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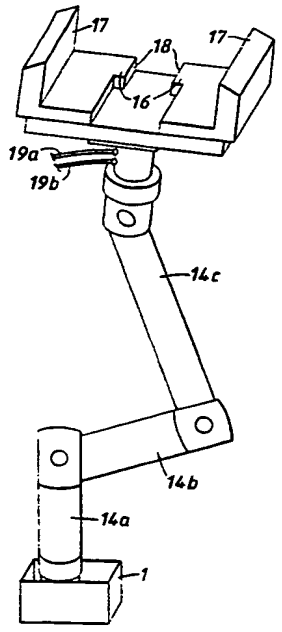

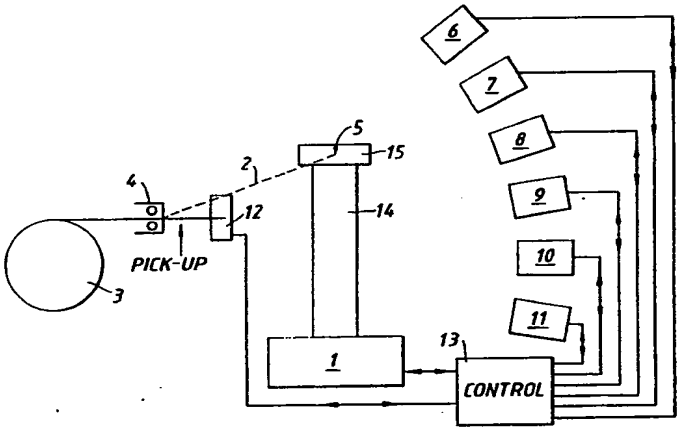

(57) Abstract

An automated optical fibre processing system in which a robot (1) conducts a fibre end to various workstations (7 to 11) where cutting, cleaving, cleaning, stripping and testing take place. To achieve exact fibre positioning during processing the fibre can be located in a cartridge at station (6) that provides a datum for operations on the fibre. The cartridge may be independent, part of the robot arm or part of a workstation. A control device (13) controls the take up of the fibre by the robot gripper (15) as well as movement to workstations and operations of the processes at the workstation.

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OPTICAL FIBRE HANDLING

This invention relates to optical fibre handling and processing and in particular to an automated optical fibre processing system for manipulating and processing such fibres.

Prior to connection of an optical fibre to other optical elements it is necessary to prepare the end of the fibre, this usually requiring several processing steps such as stripping, cleaning, cutting and cleaving. These processes have had to be preformed manually. This is time consuming, labour intensive and difficult to achieve repeatable/standardised results. It is therefore desirable to be able to mechanise the handling and processing stages and to improve the efficiency and reproducibility.

According to the present invention there is provided an automated fibre processing system comprising:

a plurality of task workstations,

a multiple axis mechanised arm including means for holding at least one fibre,

means for automatically moving the at least one held fibre from one workstation to another, and

control means for controlling each workstation to automatically perform processing tasks on said at least one fibre.

In a preferred embodiment the mechanised arm has a gripper adapted to engage with an independent fibre carrying member.

The system preferably includes a fibre cutting workstation comprising a clamp for holding the fibre and a fibre cutting means, the clamp and cutting means being interconnected by a common arm so that progressive movement of the arm first causes clamping and then cutting of the fibre. Within the context of this specification cutting includes severing and cleaving.

The system preferably includes a workstation comprising stripping blades and means for locating the fibre in a

predetermined position with respect to the stripping blades. The stripping blades may be for removing primary coating or both tight jackets and primary coatings.

A cleaning workstation is preferably provided comprising a member movable to bring the fibre into contact with a cleaning surface and means for providing a new cleaning surface for each cleaning operation.

After or during processing the end of the fibre is preferably optically tested by launching light into one end of the fibre being processed and monitoring output light at the other end.

Further, according to the invention there is provided an optical fibre workstation including:

means for receiving a fibre;

means for operating on a fibre to perform a task; and

means for driving said operating means.

The workstation could comprise a fibre cutting station, a stripping station for the fibre, a cleaning workstation, or other workstation.

The invention will now be described by was of example with reference to the accompanying drawings, in which :-

Figure 1A illustrates schematically a multi-station optical fibre handling system according to an embodiment of the invention;

Figure 1B shows a detail of the robot arm and gripper mechanism associated with Figure 1;

Figures 2A and 2B illustrate in greater detail a fibre clamp and cutting station utilised in the embodiment of Figure 1;

Figure 3A to 3G show details of a station with a fibre holding cartridge utilised in the embodiment of Figure 1;

Figures 4A and 4B illustrate a stripper at a station for removing primary coatings;

Figures 5A to 5C show details of a stripper station for removing tight jackets and primary coats;

Figures 6A to 6C illustrate a fibre cleaning station;

Figures 7A to 7B show details of a cleaving station;

Figure 8 shows details of a detector station; and

Figure 9 shows an arrangement for the control device of Figure 1.

During optical fibre end preparation it is usual for several operations to be performed, some of them repeatedly. For example to prepare a jacketed fibre for connection to a device such as a laser package, the outer tight jacket first requires stripping, then the primary coating on the fibre removed and the fibre end cleaved ready for connection or possibly some further specialised processing such as lensing. Between each stage the fibre may also be cleaned to prevent build up of dirt on the fibre and also on the handling elements. In the case of fibre having a primary coating only, this coating will also require stripping, prior to other processing.

Figure 1A shows schematically a layout for a fibre processing station in which a robot 1 is employed to manipulate optical fibres and introduce the fibre to a plurality of fibre processing workstations in a working area.

The robot includes a multi-axis arm 14 and a gripper 15 so as to have the ability to pick up and withdraw a fibre 2 from a reel within a fibre spooler 3 via a fibre dispenser 4 and then introduces the free end 5 of the fibre to the required subsidiary workstations in turn. As shown, the robot can pick-up the fibre in the region of a fibre cutting device 12. In the illustrated embodiment of the invention, the subsidiary workstations comprise a primary coated fibre stripper 7, and tight jacket fibre stripper 8, a fibre cleaning device 9, a cleaver 10 and a detector 11.

Which stripper 7 or 8 is used will depend on type of fibre to be prepared. When handling primary coated fibre, the robot can be first moved to cartridge station 6, where a fibre cartridge is located for more effectively handling the coated fibre. When the robot is handling fibre, the free end of the fibre may be required to move from a few centimetres up to three or four metres or more between

workstations and thus varying lengths of fibre may need to be unwound from the reel. Optical fibre is delicate compared with metal wires, and any damage might impair the quality of the fibre in subsequent use, so to avoid damage through excessive tension during optical fibre handling it is generally the case that more slack tends to be unwound during handling than for example when manipulating conventional electrical wires. However if the slack is excessive this can result in risk of damage through bending through too small a radius. A suitable spooler is described in greater detail in our copending patent application entitled ' Spooler System'.

As shown in Figure 1A, a control device 13 interacts between the robot 1 and locations 6 to 12 allowing control and detection signals to be passed and received. Proximity or operational sensors could be provided at the various stations. Handling fibre in any mechanised way can be difficult, and many of the processing operations require accurate location of the fibre. With tight jacket fibre the gripper 15 can handle the fibre throughout operations. With primary coated fibre which is more delicate, the primary coated fibre is preferably held in the cartridge within station 6, after being placed there by the robot. In both cases either the gripper or the cartridge provide a standard datum and fibre orientation for accurate movement to the various stations to effect the desired operations.

In the preferred embodiment (see Figure 1B) the robot 1 has a six-axis mechanical arm 14a - 14C the end of which has a double gripper 15 comprising a pair of inner jaws 16 intended to hold fibre, and a pair of outer jaws 17 of larger dimensions intended to hold the fibre cartridge. Pneumatic lines 19a, b, operate the jaws in respective directions. To commence operations the robot, using the inner jaws, picks up a free end of the fibre extending from the reel. Rubber pads 18 grip the fibre securely but without damaging it. During sequences of fibre processing operations this free end will usually be at a fibre clamp

and cutting device 12 of Figure 1, shown in more detail in Figures 2A and 2B, positioned between the fibre spooler and the robot. The cutting device is used between processed fibre lengths typically as a final stage, the robot subsequently picking it up adjacent the new end that extends from the reel and is at device 12.

In an alternative arrangement, two cartridges would be used - one to accommodate tight jacket fibre, the other for primary coated fibre.

The cutting device (see Figure 2) comprises a fixed base 20 having a V-groove fibre locator 21, and a moving arm 22 pivoted about a pivot 23 by means of a gas solenoid 24. When a fibre, which will be a fibre that is coated or jacketed as on the reel, is in position in the V-groove, the moving arm is pivoted clockwise as illustrated in Figure 2B by the gas solenoid such that a fibre clamp 25 biassed from the moving arm by means of a spring 26, clamps the fibre in the groove and on further clockwise pivoting of the moving arm a cutting blade 27 severs the fibre. As this normally would be the final phase of operations, at the commencement of operations the fibre will have been severed, typically, and the free bulk end held in device 12.

Having picked up the free end of the fibre at the device 12, the robot arm and gripper then moves to place the fibre (if primary coated) in a cartridge 29 at cartridge station 6 of Figure 1 as illustrated in more detail in Figures 3A to 3D.

The cartridge 29 is positioned on a fixed base 30 of a cartridge holder 6 shown separately in Figures 3E to 3G, an electro-magnet 31 being energised to hold the cartridge in position on the base. A swing arm 32 activated by a gas solenoid 33 opens a lid 34 of the cartridge 29, against a force supplied by a permanent magnet 35 mounted in the lid. (Electromagnet 31 has a stronger retaining force than that required to secure the lid against the magnetic force of magnet 35). On opening the lid, the fibre is then laid in the cartridge by the robot so that it falls into a self-

locating V-groove 36. When the fibre has been positioned in the V-groove the lid is closed and a anti-static resilient rubber strip 37 assists in holding the fibre whilst preventing damage to the fibre. The robot then releases the fibre. The permanent magnet on the lid of the cartridge holds the lid closed, clamping the fibre in the base of the V-groove. The fibre is positioned in the cartridge such that the free end protrudes beyond the exit face of the cartridge to allow operations to be carried out on it whilst firmly clamped.

As mentioned above, once the fibre has been clamped in the cartridge, typically as detected by proximity switch detectors at the station (not shown), the robot is instructed to release the fibre and manoeuvres to pick up the cartridge in the outer gripper jaws 17. For some workstations a cartridge may be built as part of the workstation, for example if only one processing workstation is required, or the cartridge may form part of a customised robot arm. One of the principle functions of the cartridge is that it can handle the delicate primary coated fibre and acts as a datum for subsequent fibre handling processes, the cartridge being accurately located typically within or against a complementary part on other apparatus. The cartridge also acts to support the fibre correctly orientated, with a short length of the fibre protruding in a known direction, relatively rigidly beyond the fibre exit face of the cartridge. Typically, in a subsequent procedure the length of fibre protruding beyond the exit face of the cartridge is cut to a known length to facilitate following processing stages. This may be done using the cutting device 12, or the cleaving device 10 described later with reference to Figure 7. A cutting device could also be made integrally with the cartridge. Typically, after location within the cartridge, the coated fibre is stripped at station 7.

Figure 4A and 4B illustrate a primary coated fibre stripper at station 7 comprising two jaws 41 and 42, with

sharp edge V-shaped recesses 43 which constitute the stripping blades. Jaw 41 is held stationary in a fixed base 44, and jaw 42 is pivoted about pivot 45 by means of a gas solenoid 46. The cartridge held in the robot jaws is brought in to register with a guide (not shown) to control the positioning of the free end of the fibre between the recesses 43 and after the jaws have closed draws the fibre through the stripper jaws a programmed distance. The movement may be by movement of the robot arm (and thus the fibre) or the jaws may be mounted for movement. An air blast or a vacuum is provided by nozzle 47 to remove debris from around the stripper jaws. If the robot were operating in a clean room a vacuum could be used instead of air, to remove debris from the clean room. Sensors detecting correct operation (not shown) can be provided to send appropriate signals to the control system 13 of Figure 1. Reproducible results are obtained by virtue of the fact that the fibre end protrudes beyond the cartridge by a known length and the length and speed of travel during stripping is also controlled.

It will be seen that this stripper could be bench-mounted for use without a robot or on a semi-automated bench requiring manual loading. If it were to be used as a bench tool a cartridge could be provided on the bench and a push button operated, for example, to close the cartridge and pull the fibre through the stripper. Other stations could be similarly operated.

A second stripping device at station 8 this time for tight jacketed fibre is illustrated in Figures 5A to 5C. The free end of the fibre (which may have some degree of bend or set) is inserted in the direction of arrow 57 through a cone shaped aperture 50 at one end of the stripper and into a stripping element 51 which includes closeable cutting edges that engage around the fibre. The length of fibre inserted is controlled by the location of the fibre carrying member (e.g. the robot gripper) and the predetermined length of protruding fibre end. A slider 52

fitted on a fixed base 53 opens or closes the stripper device, and a gas solenoid 54 causes the stripper device to slide backwards axially of the fibre and strip the jacket in one pass, such that the stripped pieces drop down in the direction of arrow 55 to be collected in a tray for disposal (not shown). The stripper 8 has a front plate 56 which may be removable to change or replace the stripper device. Sensors (not shown) could provide signals indicative of correct operation to control 13 of Figure 1.

If this tight jacket fibre stripping were to be performed by hand it has been found to be a very slow process; the procedure being for the jacket to be nibbled away gradually. The automated stripper device described above removes the tight jacket coating and strips the primary coating of the fibre to the core in one operation in a better and reproducible manner (e.g. 20mm length).

A particular advantage of the automated process is that the fibre is maintained at the correct orientation (usually 90°) to the cutting edges of the strippers, which cannot be reliably ensured manually, and the cutting edges in their controlled location do not therefore damage the fibre. This applies to stripping using the Figure 4 or Figure 5 embodiments.

After stripping, the fibre is often subject to residual waste which requires cleaning. Station 9 of Figure 1 relates to the cleaning task and Figures 6A to 6C show details of the fibre cleaning device which comprises a fixed base 60 and a moving arm 61 pivoted about a pivot 62 by means of a gas solenoid 63. The fixed base and moving arm have internal rubber pads 69 over which lint free paper 64 passes. The paper comes from two paper rolls and is wound on automatically by means of a winding mechanism 65 comprising a pawl and ratchet attaching to rollers 65a. The paper moves along two paths over fixed guides 65b in the cleaning device in the direction of arrows 66. A jet of cleaning solvent is sprayed from dispensers 68 onto both paper strips in the region of the rubber pads 69 from a

reservoir 68b via electric pump 68a under the control of control unit 13 of Figure 1. A fibre 67 is inserted between layers of paper 64 on the inside faces of the fixed base and moving arm. The gas solenoid 63 is operated to close the moving arm to bring the paper into cleaning contact with the fibre. The robot arm then pulls the fibre through the paper to effect cleaning. As the moving arm opens again the pawl and ratchet automatically advances the paper from each of the two rolls. The robot withdraws the fibre and rotates the fibre through 90 degrees around the axis of the fibre.

Meanwhile another jet is solvent is dispensed, the fibre inserted and the moving arm is again pivoted closed to wipe the fibre on a clean area of paper. Automatic advancement of the paper ensures that the fibre is always wiped on clean paper; a manual operator could not be relied upon to do this consistently. Again the automated cleaning provides improved, consistent results compared with manual cleaning and less prone to handling damage. The cleaner may be used several times between other procedures if desired. Sensors including paper and fluid presence sensors can be incorporated to indicate operational activity to the control 13 of Figure 1.

After cleaning, cleaving of the fibre may be the next operational step required. The robot arm moves to the appropriate workstation 10 of Figure 1 and details of the cleaver therein are shown in Figures 7A and 7B. This comprises a fixed base 70 and a pivotable cleaver arm 71. A fibre 72, held by the robot arm in the gripper (possibly in the fibre cartridge) is placed on the support 76 on the fixed base and a gas solenoid 73 pivots the cleaver arm into the closed position as directed by control 13 of Figure 1. A clamp 74 moves with the arm to contact the fibre and hold it in position for the diamond cutter 75 to cleave the fibre. The clamp 74 may be biassed or have a click stop mechanism.

The robot arm, as the cleave is being carried out, typically moves down slightly so as to tension the fibre as

it is clamped, especially if support 76 is of resilient material. This helps in ensuring a successful cleave. Solenoid 73 is operable under the control of device 13 of Figure 1. Sensors (not shown) can provide signals back to control 13 indicative of arm closure for example.

The final subsidiary workstation is the embodiment of the invention shown in Figure 1 comprises a detector station 11 which checks whether the fibre has been damaged during processing. The robot arm under the control of the controller 13 moves to the workstation 11 shown in more detail in Figure 8. A guide plate 80 receives the gripper and the fibre extending therefrom passes through aperture 82 in detector 81. A laser 84 produces a light source and this light is supplied at the end of the fibre which is still on the spooler reel 3. The detector 81 takes a reading of the light signal transmitted through the fibre and passes it to a lock-in amplifier 83 and hence to a computer 85 which compares it with a known standard reading. A reverse testing system utilising a laser to transmit light into the newly processed end with a detector on the spooler may alternatively be used: this is particularly suitable if the robot system is being used to fabricate fibre tails for attachment to lasers or waveguides. In the event that the test shows a poor response the fibre end is reprocessed using some of the earlier workstations under the controller 13 of Figure 1.

The controller 13 of Figure 1 can be configured as shown in Figure 9. By way of example the controller 13 is shown as cooperating with the detector system of Figure 8.

The controller includes a computer 90 which can control the devices including the robot. Access to the computer can be, for example, by keyboard 92 with associated VDU 91. A floppy disc drive is also provided. The computer 90 will also provide control signals to the various workstations via a parallel input/output interface 93 (e.g. 32 bit). The robot 1 will be programmed to move to the various stations with rotation and adjustment of the gripper as required.

The six-axis manipulation, in addition to gripper jaw opening and closing, allows the desired degree of dexterity to be achieved. Operation of the device at any particular workstation will be instigated by the computer 90 when the fibre is at that particular station. The interface 93 typically provides power voltages to the remote actuators (e.g. to activate the cylinders) when instructed by the computer. Inputs from the proximity sensors on the various workstations send confirmatory signals to the computer via the interface 93 that operations have been effected. Active sensing reduce the risk of operational errors. Additional active sensing to the activities described could be provided. In the case of specialised sensing, such as the laser testing system, a bus 94 (e.g. 8 bit IEEE 488 bus) is provided to communicate between system devices.

Additional or alternative workstations could be provided such as a fibre fusion/splicing station. By modifying the jaws or the cartridge, more than one fibre could be handled.

CLAIMS

1. An automated fibre processing system comprising a plurality of task workstations,

a multiple axis mechanised arm including means for holding at least one fibre,

means for automatically moving the at least one held fibre from workstation to another, and

control means for controlling each workstation to automatically perform processing tasks on said at least one fibre.

2. A system as claimed in claim 1 wherein the arm includes means for picking up at least on fibre.

3. A system as claimed in claim 2 wherein the pick up means and the holding means comprises a gripper attached to said arm.

4. A system as claimed in claim 1 or 2 wherein the holding means includes a gripper and an independent fibre carrying cartridge for holding the at least one fibre whilst tasks are performed thereon.

5. A system as claimed in any preceding claim, wherein the control means includes detector means for detecting the completion of a task and feedback means provide a signal to the control means indicative of detected task completion to initiate a further processing task.

6. A system as claimed any proceeding claim, wherein the control means includes selector means for selecting one or more processing tasks at one or more workstations.

7. A system as claimed in claim 6 wherein the selector means includes keyboard entry means and solenoid means effect task operation at the workstations.

8. A system as claimed in any preceding claim wherein the holding means has a groove for location of the fibre and a clamp with a magnetic catch to retain the fibre within the groove.

9. A system as claimed in claim 8 in which the clamp comprises a pivoted lid.

10. A system as claimed in any preceding claim in which the fibre holding means further comprises a cutting means.

11. A system as claimed in any preceding claim including a fibre cutting workstation comprising a clamp for holding a fibre and a cutting means, the clamp and cutting means being interconnected by a common arm so that progressive movement of the arm first causes clamping and then cutting of the fibre.

12. A system as claimed in any preceding claim in which the holding means is engageable with a fibre cutting device such that the free fibre end is cut to a predetermined length.

13. A system as claimed in any preceding claim including a workstation for stripping coatings from optical fibre, the workstation comprising stripping blades and means for locating the fibre in a predetermined position with respect to the stripping blades.

14. A system as claimed in claim 13 in which the closure of the stripping blades and relative speed and distance of travel of the jaws and fibre are controlled in a programmed sequence.

15. A system as claimed in claim 13 or claim 14 in which the stripping blades comprise jaws for removing primary coatings alone or simultaneously removing both tight jackets and primary coatings.

16. A system as claimed in any of claims 13, 14 or 15 in which the means for locating the fibre in a predetermined position comprises means for engaging with the fibre holding means.

17. A system as claimed in any preceding claim including a workstation for cleaning the remnants of coating or other debis from the fibre, the workstation comprising a member moveable to bring the fibre into contact with a cleaning surface and means for providing a new cleaning surface for each cleaning operation.

18. A system as claimed in any preceding claim including a workstation forming a transmission testing stage comprising means for launching light into one end of fibre being processed and means for monitoring output light at the other end and interface means for sending information to the control means to indicate acceptance or rejection of tested fibre.

19. A system as claimed in claim 18 in which the transmission testing stage is conducting while the fibre is wound on a supply reel, one of the launching or monitoring means being located at the fibre end on the reel.

20. An optical fibre workstation including:
means for receiving a fibre;
means for operating on a fibre to perform a task; and
means for driving said operating means.

21. A workstation as claimed in claim 20 wherein the driving means comprises a solenoid interconnected with the operating means.

22. A workstation as claimed in claim 20 or 21 wherein said driving means is operable in response to manual initiation via switch means.

23. A workstation as claimed in claim 20, 21 or 22 wherein the means for receiving a fibre includes a cartridge for retaining a fibre in a predetermined manner.

24. A workstation as claimed in any one of claims 20 to 23 wherein the workstation comprises a fibre cutting workstation including a clamp for holding the fibre and a fibre cutting means, the clamp and cutting means forming the operating means and being interconnected by a common arm driven by said driving means so that progressive movement of the arm first cause clamping and then cutting of the fibre on actuation of the driving means.

25. A workstation as claimed in claim 24 in which the clamp is resiliently biassed.

26. A workstation as claimed in any one of claims 20 to 23 wherein the workstation is for stripping a coating from an optical fibre said operating means comprises a stripping blade, and said receiving means is configured to locate the fibre in a predetermined position with respect to the stripping blade.

27. A workstation as claimed in claim 26 where in means are provided to move at least part of the fibre relative to the blade position, the closure of the stripping blade and movement of the fibre being controlled in a predetermined manner by solenoid driving means.

28. A workstation as claimed in claim 26 or 27 wherein the stripping is configured to remove primary coatings, or to remove simultaneously both tight jackets and primary coatings.

29. A workstation as claimed in any one of claims 20 to 23 wherein the workstation comprises a fibre cleaning workstation for cleaning remnants of fibre coatings or other

debris, the operating means includes a member moveable to bring the fibre into contact with a cleaning surface when driven by said driving means and including means for providing a new cleaning surface for each cleaning operation.

30. A workstation as claimed in claim 29 wherein the cleaning surface is formed from material provided on a roll and means are provided to increment the material to the cleaning position and wherein fluid means are provided from a reservoir to assist in the cleaning of the fibre.

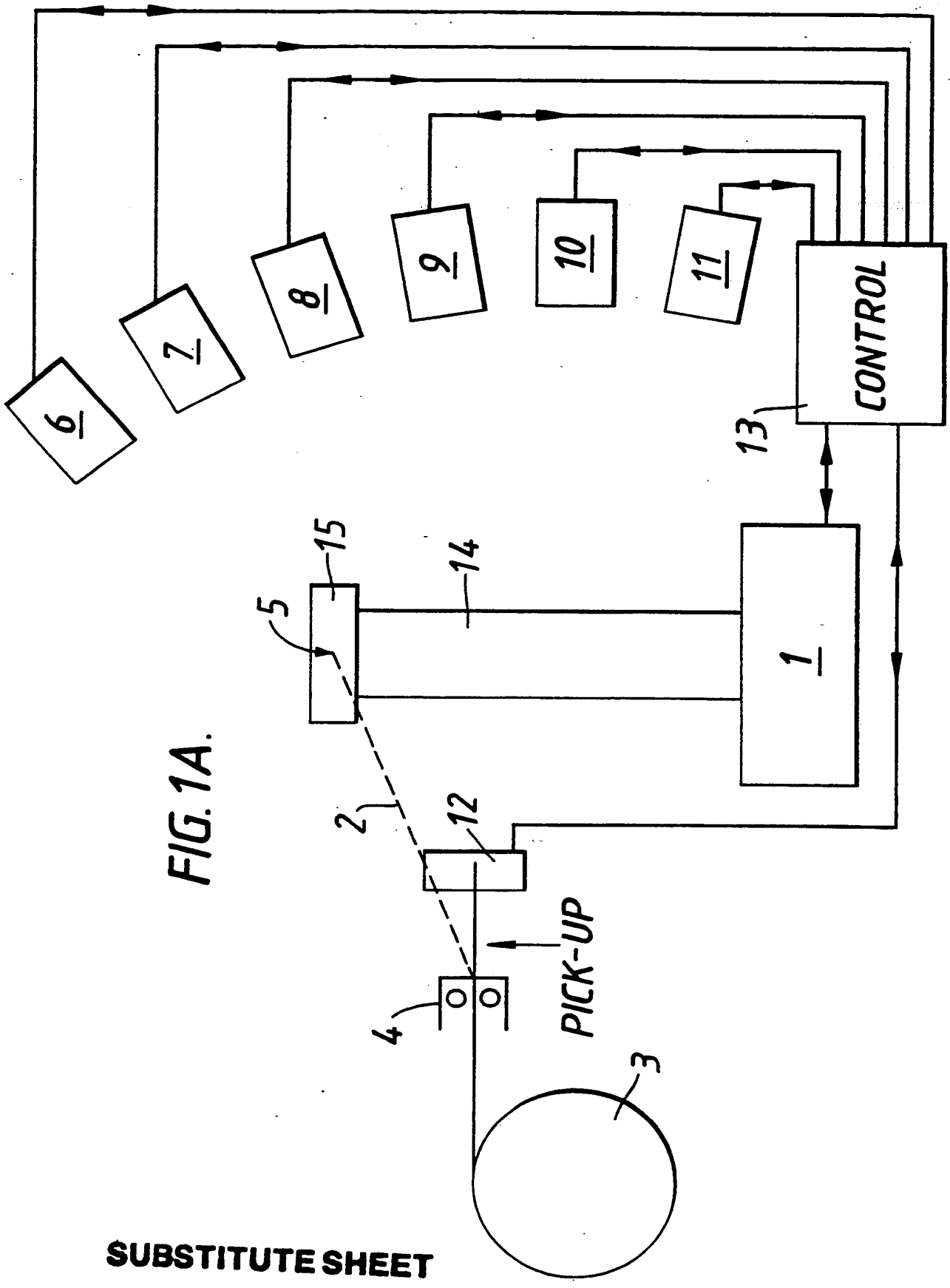


FIG. 1A.

FIG.1B.

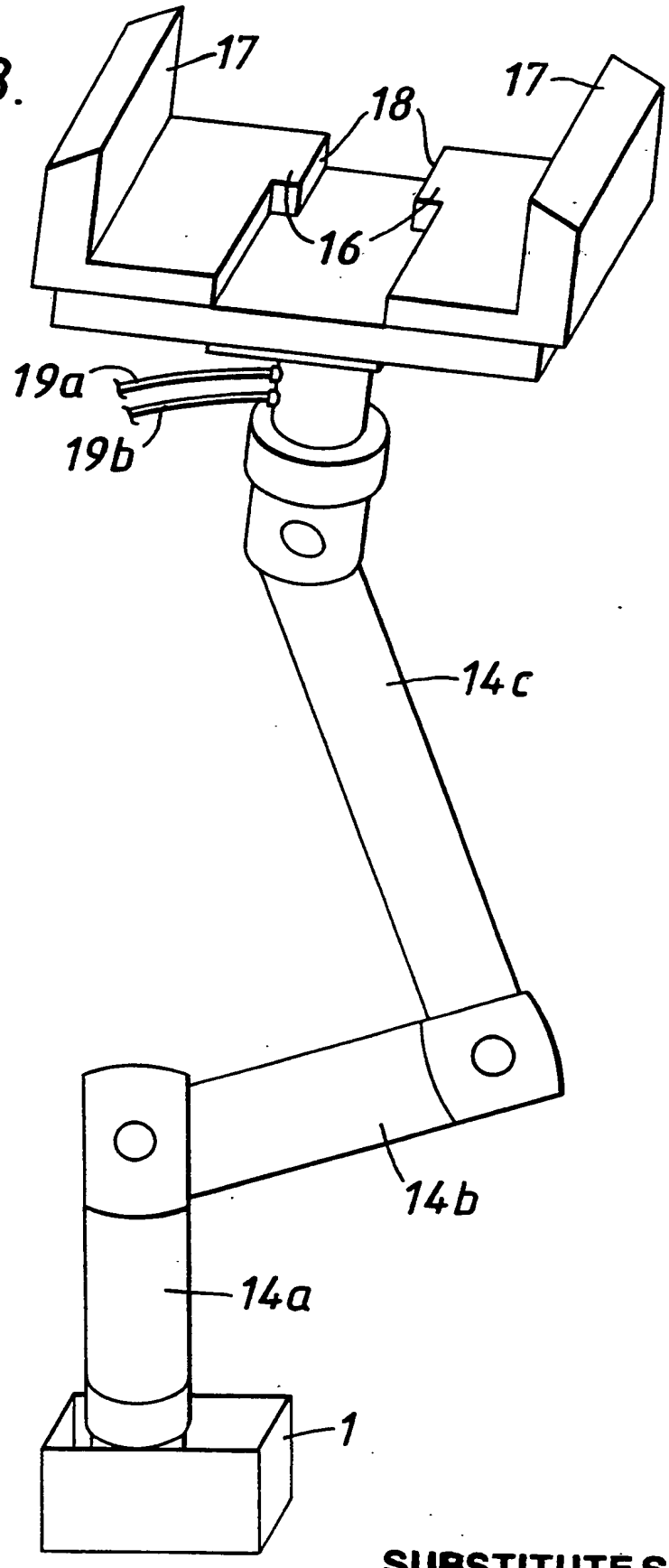


FIG. 2A.

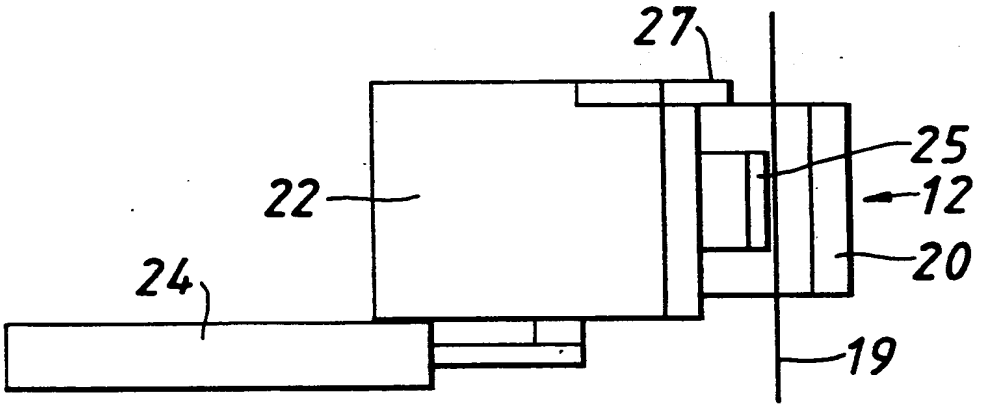
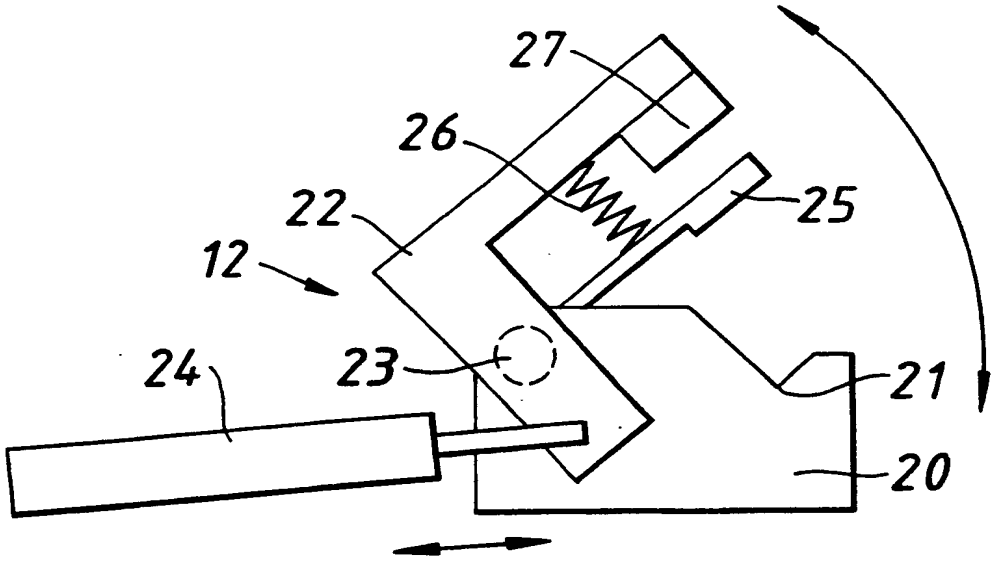


FIG. 2B.



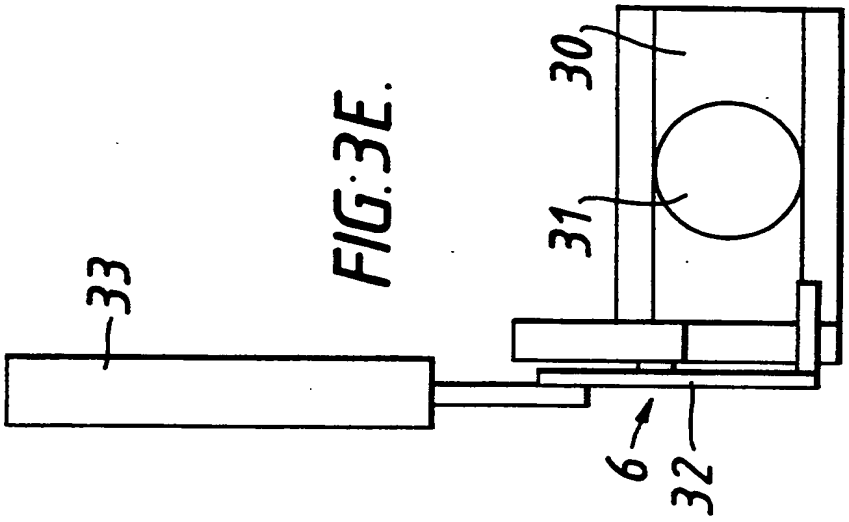


FIG.3E.

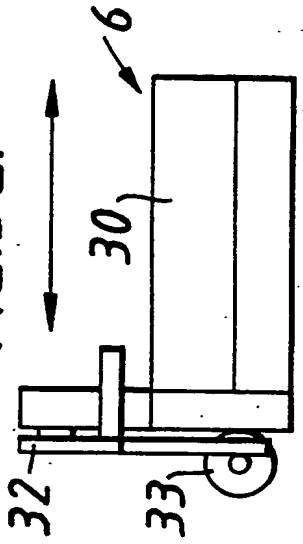


FIG.3G.

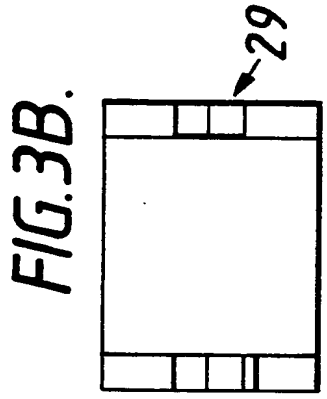


FIG.3B.

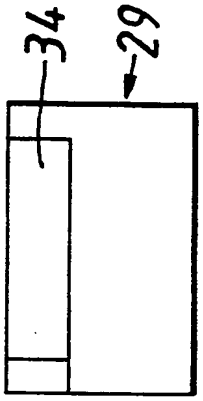


FIG.3D.

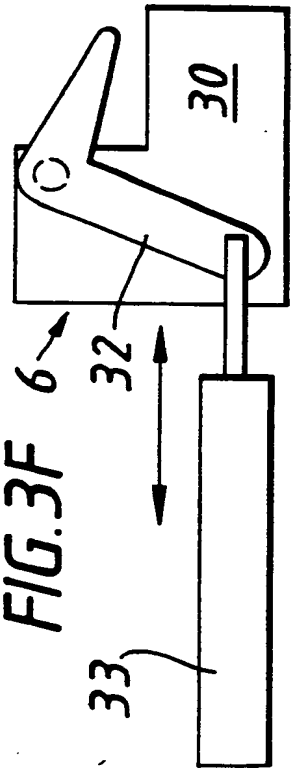


FIG.3F

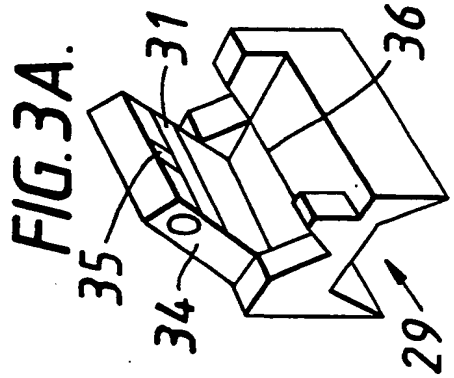


FIG.3A.

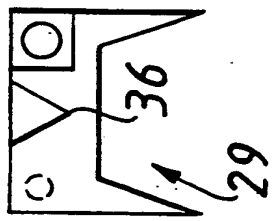


FIG.3C.

FIG. 4A.

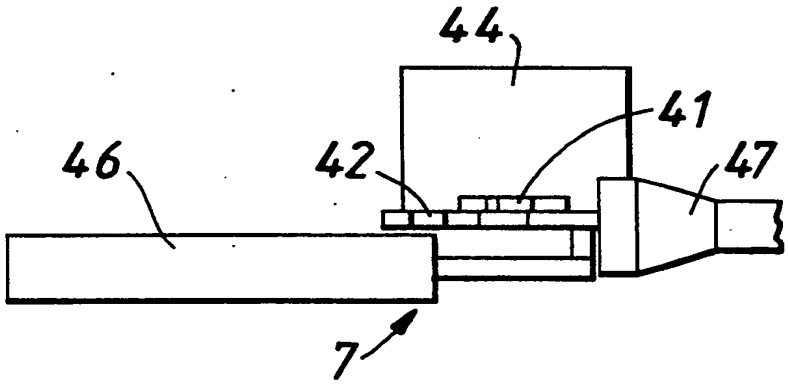


FIG. 4B.

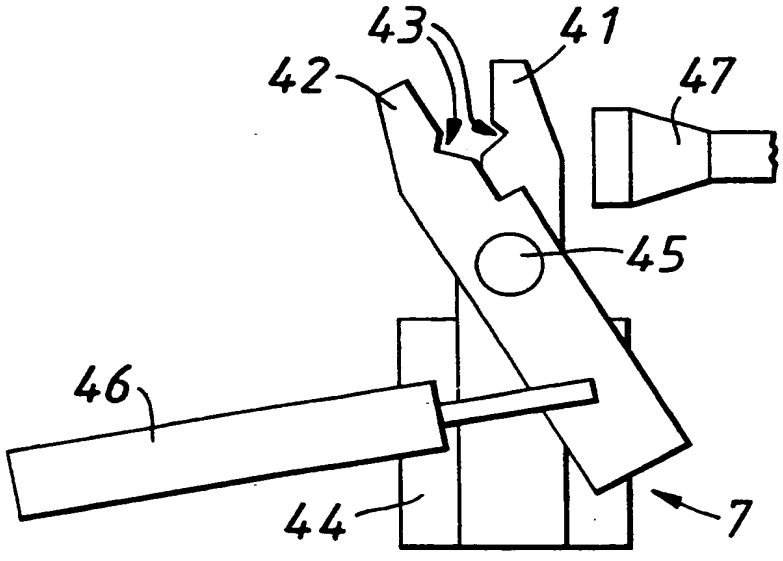


FIG. 5A.

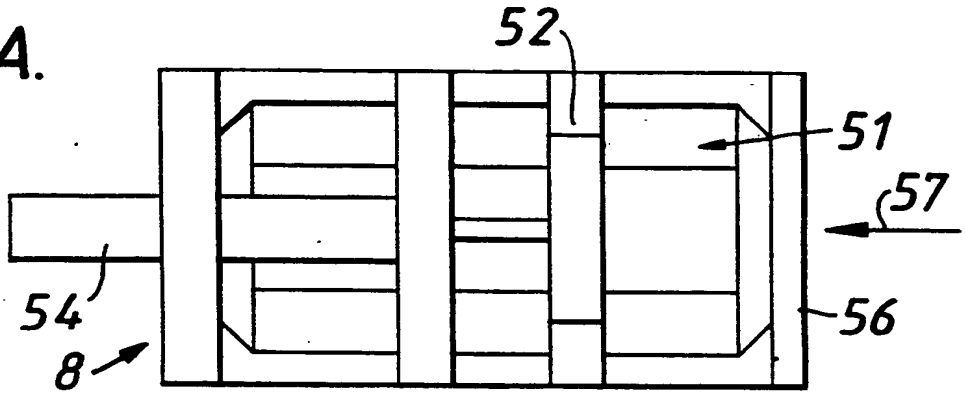


FIG. 5B.

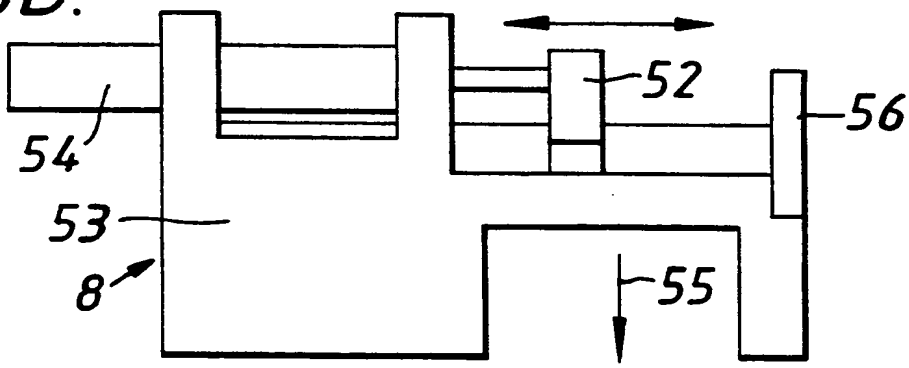


FIG. 5C.

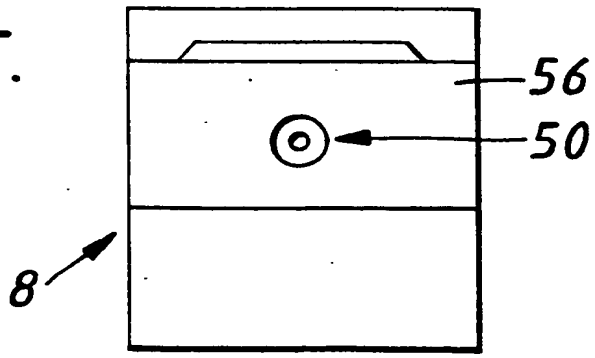


FIG.6C.

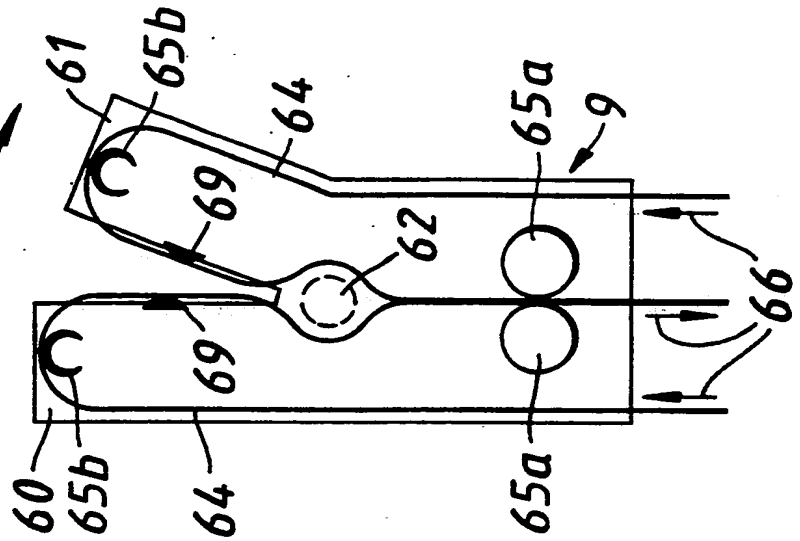


FIG.6A.

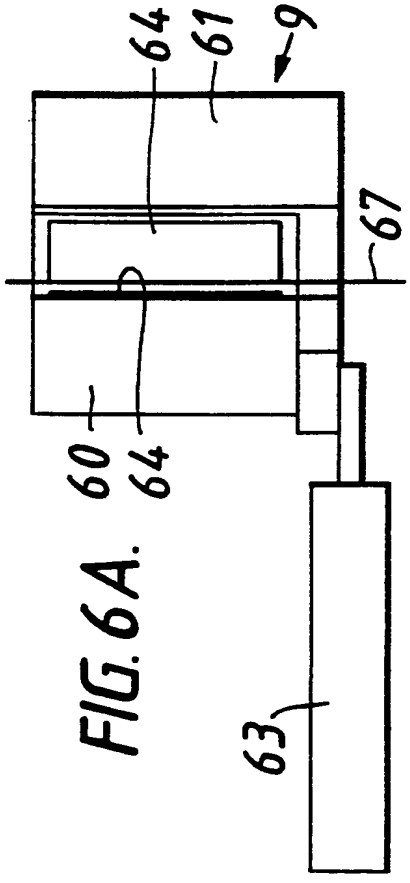
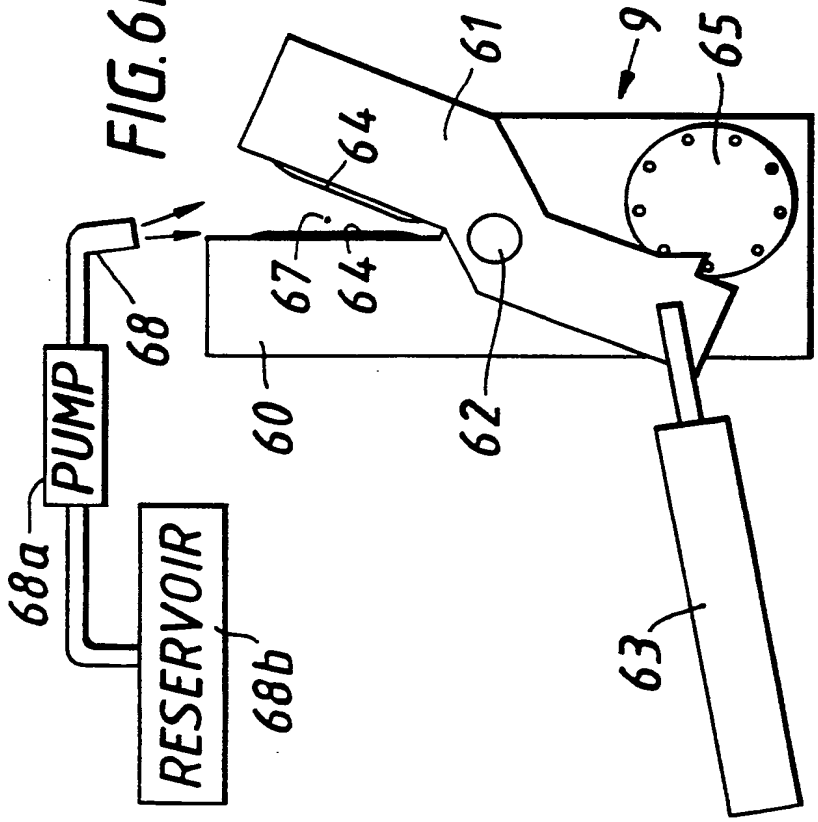


FIG.6B.



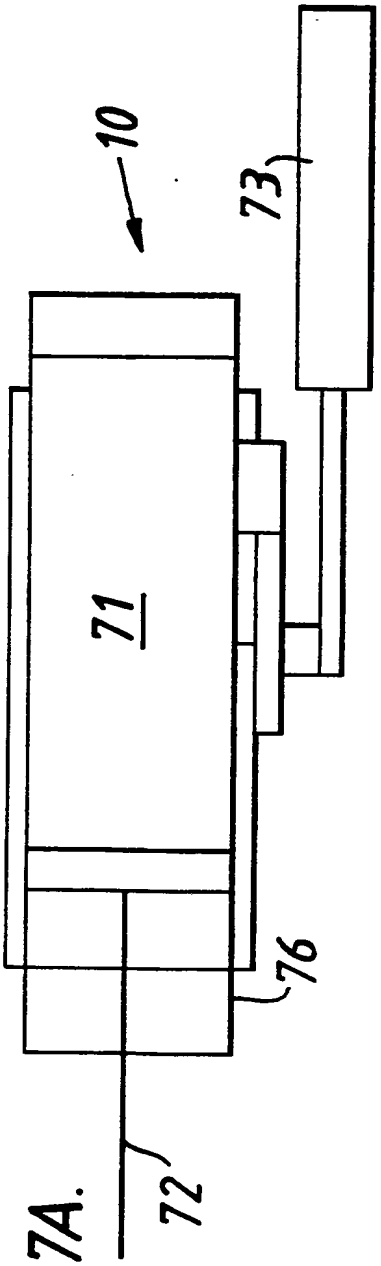


FIG.7A.

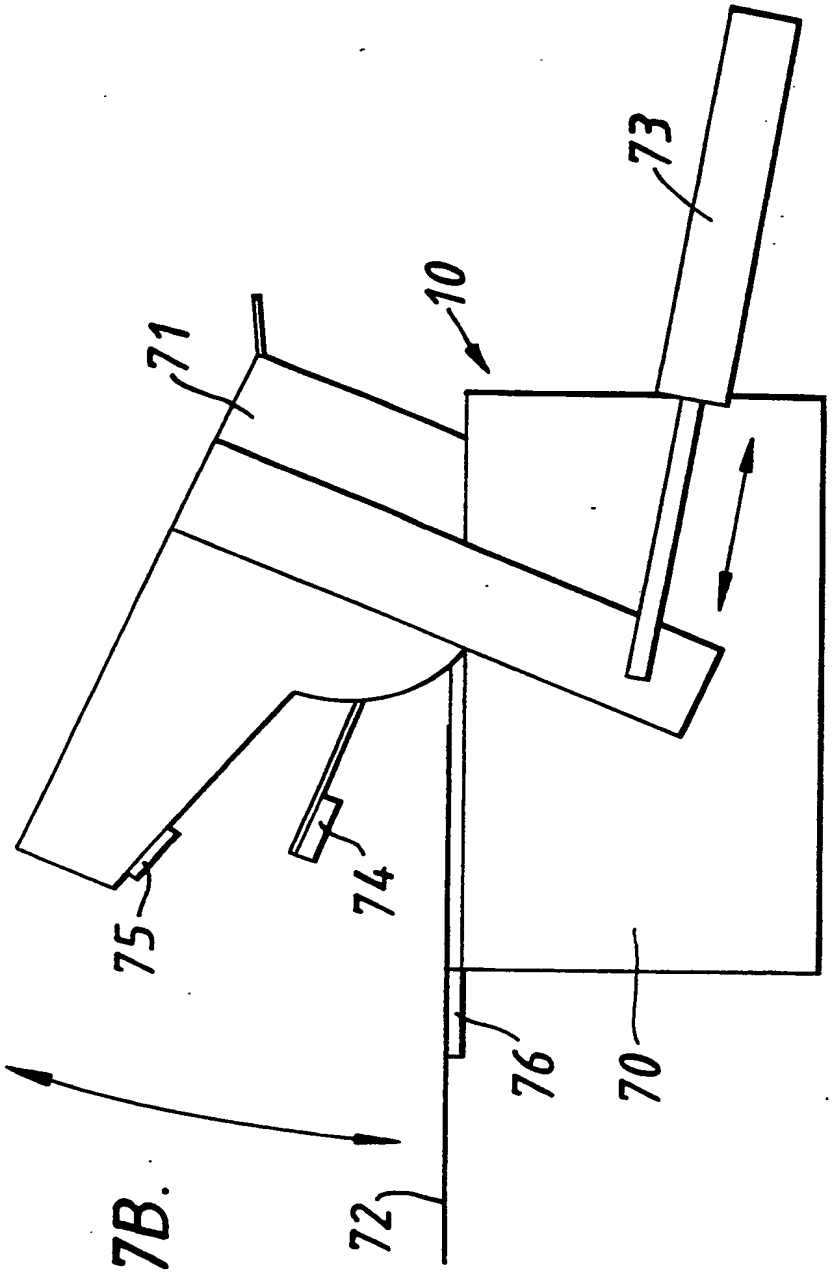
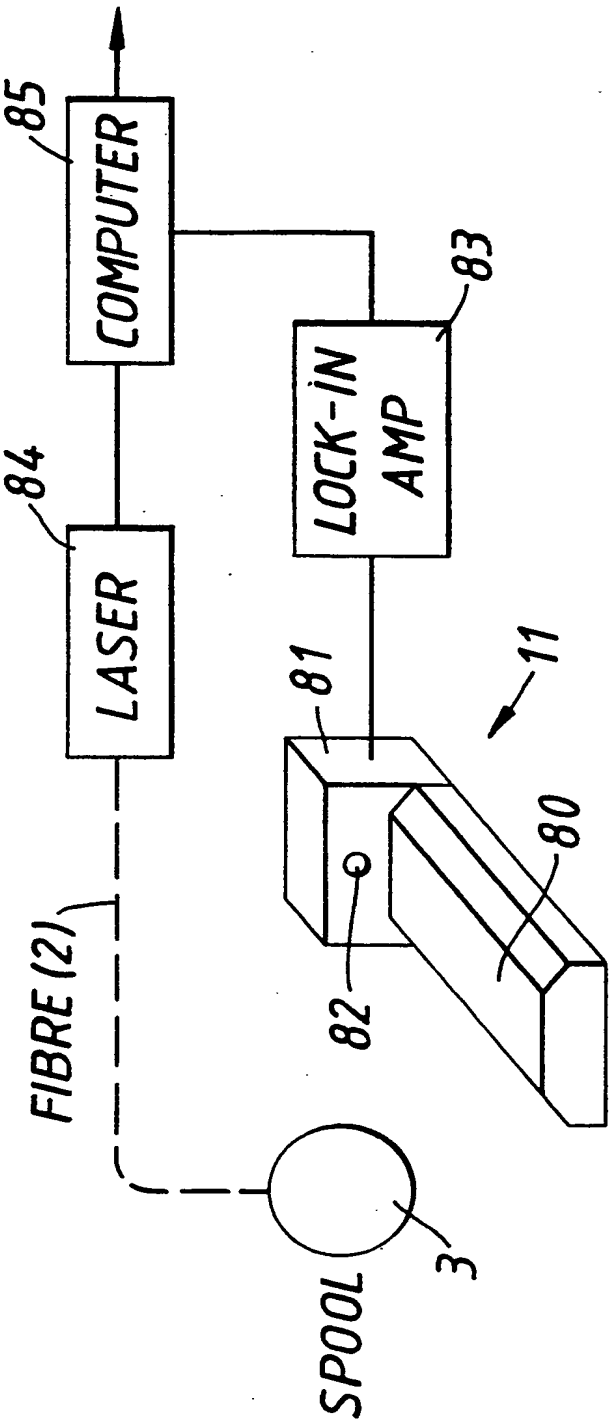


FIG.7B.

FIG. 8.



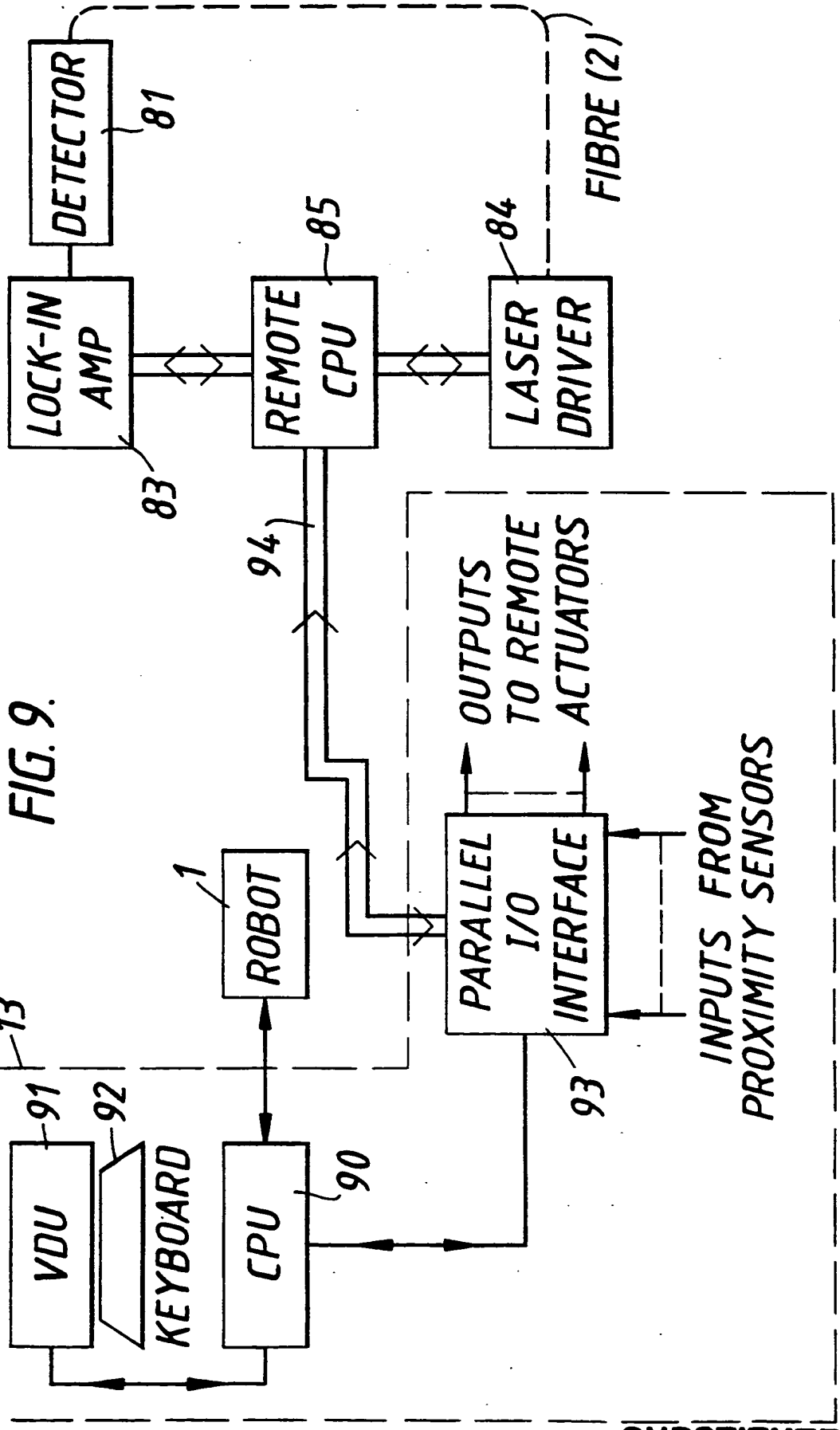


FIG. 9.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 91/00361

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[5]: C 03 B 37/16

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[5]	C 03 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	FR, A, 2565581 (ETAT FRANCAIS PTT) 13 December 1985 see page 5, line 25 - page 7, line 31; figures 4,5 ---	1,20,23
X	EP, A, 0307110 (NORTHERN TELECOM LIMITED) 15 March 1989 see the whole document ---	1,20
X	Patent Abstracts of Japan, volume 10, no. 225 (P-484)(2281), 6 August 1986 & JP, A, 61062007 (FURUKAWA ELECTRIC), 29 March 1986 see the whole document ---	20
X	Patent Abstracts of Japan, volume 9, no. 259 (P-397)(1982), 17 October 1985 & JP, A, 60108803 (NIPPON DENSHIN DENWA KOSHA), 14 June 1985 see the whole document --- ./.	20

* Special categories of cited documents: [10]

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
4th June 1991	23. 07 91
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	Natalie Weinberg

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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

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A	Japanese Patent Gazette, section 9, week 8833, 7 August 1988, Derwent Publisher, see class f, nr. 88-231795133 & JP, A, 63165576 (KURARAY), 7 August 1988	
A	EP, A, 0295374 (FUJIKURA) 21 December 1988	
A	Patent Abstracts of Japan, volume 6, no. 198 (P-147)(1076), 7 October 1982, & JP, A, 57108801 (NIPPON DENSHIN DENWA KOSHA), 7 July 1982	
A	Patent Abstracts of Japan, volume 5, no- 96 (P-67)(768), 23 June 1981, & JP, A, 56039502 (NIPPON DENSHIN DENWA KOSHA), 15 April 1981	
A	DE, C, 3341919 (ANT) 17 January 1985	
A	DE, A, 3019264 (SIEMENS) 26 November 1981	

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9100361 SA 45323

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 09/07/91
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EP-A- 0307110	15-03-89	AU-A- 2090288	16-03-89
		US-A- 4852244	01-08-89
EP-A- 0295374	21-12-88	JP-A- 1007089	11-01-89
		JP-A- 1112206	28-04-89
		JP-A- 1126601	18-05-89
DE-C- 3341919	17-01-85	None	
DE-A- 3019264	26-11-81	None	